

Fig. 1

Results: The phantom values obtained with VNA and fit with the TOPPCAT program compare favorably to the VFIRFT approach (Figure 1). The results from OA subjects are shown in Table 1 and compare favorably to literature values obtained with variations on inversion recovery techniques. We have included values from muscle as a reference and indication of upper limits of dynamic range of the technique.

Table 1. Summary T1 Results

Tissue Compartment	Mean T1	Standard Deviation T1
LatTibiaCart	478	170
MedTibiaCart	504	145
LatFemoralCart	481	75
MedFemoralCart	580	93
Muscle	983	178

Conclusions: The variable nutation angle approach has been shown to provide an efficient means of improving the spatial resolution of GAG depletion mapping using dGEMRIC with minimal impact on the T1 dynamic range. The approach adds water excitation to eliminate chemical shift artifacts and the VNA inherently minimized issues of residual eddy currents as the gradient duty cycle is constant across flip angles. Further, the spatial resolution has been improved by approximately a factor of 6 with an modest increase in scan time.

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AUTOMATIC CARTILAGE VOLUME ESTIMATION FROM LOW-FIELD KNEE MRI: A LONGITUDINAL STUDY

J. Folkesson¹, E.B. Dam¹, O.F. Olsen¹, P.C. Pettersen², C. Christiansen²

¹IT University of Copenhagen, Copenhagen, Denmark, ²Center for Clinical and Basic Research, Ballerup, Denmark

Purpose: In clinical studies of the articular cartilage status in osteoarthritis (OA) research, manual cartilage segmentation can be time consuming and prone to inter- and intra-observer variability. Low-field MRI offers a cost efficient alternative to high-field scanners at the expense of lower image quality. If low-field scanners can be shown to be useful in clinical studies the costs would be reduced significantly. We have developed a fully automatic cartilage segmentation tool for magnetic resonance imaging (MRI) data, and the aim of this study was to evaluate if volume changes over time in test subjects with OA are detectable in low-field MRI data using the automatic segmentation method.

Methods: We studied 434 knee MRI scans from 217 knees scanned twice within a 21 month interval. The test subjects were 43% females, 21-80 years old at baseline, and both the left and right knees of the subjects were examined. The scans were acquired from an Esaote C-Span low-field 0.18 T scanner performing a Turbo 3D T1 sequence with almost isotropic voxels with a side length of 0.8 mm. According to Kellgren-Lawrence (KL) indices established by x-ray, 110 knees were healthy (KL=0) at baseline, and 68, 22, and 14 knees had KL = 1, 2 and 3 respectively.

An automatic software method was used to segment the medial tibial and femoral cartilage compartments in the scans automatically, using a voxel classification method based on supervised learning where each voxel is assigned to one of three classes (tibial or femoral cartilage or background) based on prior knowledge of the cartilage structure.

From the segmentation the volume was obtained and volume estimates at baseline were compared to volumes estimated using the same method from scans obtained 21 months later.

In order to determine the reproducibility of the method, 31 knees were scanned within a week after baseline and the automatically obtained volume estimates were compared to the corresponding values at baseline.

Results: The volumes of medial tibial and femoral cartilage from clear OA knees (KL > 1) decreased with 6.7% over 21 months, which is a statistically significant decrease according to a paired right-sided t-test ($p = 0.0017$). The volume loss correlates with OA status (Fig. 1). In healthy knees there was an average volume difference of 1.2%.

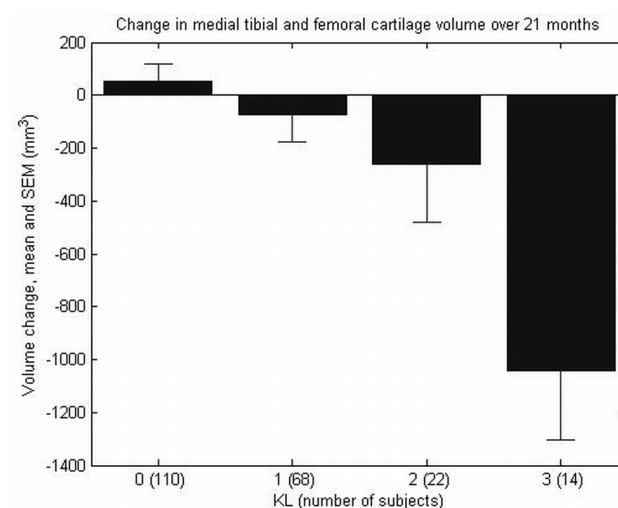


Fig. 1

The inter-scan reproducibility was determined by pairwise comparison of the 31 knees scanned twice within a week at baseline. The pairwise mean volume difference was 0.3%, and the linear correlation coefficient was 0.95.

Conclusions: The results demonstrate that the cartilage volume estimate from automatic segmentation can detect volume changes in medial cartilage over 21 months in OA knees with statistical significance ($p = 0.0017$), the average volume decrease was 6.7% and it is correlated with OA progression as determined by KL index. Besides enabling the detection of volume changes over time in OA test subjects, the automatic segmentation method is reproducible and fully automatic. Therefore the method may become a cost efficient tool in clinical studies using low-field MRI.